[0060] The standardization is performed using the following equation:

$$NC_{ij} = \left(\frac{C_{ij} - C_{\min}}{C_{\max} - C_{\max}} \right) \times K$$

where, NC_{ij} is a standardized image data value of a pixel disposed at a point (i,j), C_{ij} a non-standardized image data value of the pixel disposed at the point (i,j), $C_{\min}$ is a minimum value of image data within the numerical target zone, $C_{\max}$ is a maximum value of image data within the numerical target zone, and K is a constant, which represents the number of total gradations of the monitor.

[0065] Still further, the method may include forming mesh lines for dividing a screen of the monitor into a plurality of sub areas on the displayed image, thereby enabling the operator to designate at least one sub area as the numerical target zone.

[0070] In accordance with another aspect of the present invention, there is provided an apparatus for numerically analyzing a growth degree of grains on a surface of a semiconductor wafer. The apparatus includes a scanning electron microscopy (SEM) for scanning a specific portion of the surface of the semiconductor wafer to generate an image signal. An analog-to-digital conversion section converts the image signal generated by the scanning electron microscopy (SEM) into digital data, and then a computer section stores the digital data as an image file. The computer carries out a sequence of operations including opening the stored image file to automatically select a numerical target zone for numerating the growth degree of grains on the specific portion of the wafer, performing a standardization with respect to image data of respective pixels disposed within the selected numerical target zone, comparing the standardized image data values of the respective pixels with a predetermined threshold value to thereby count the number of pixels whose

standardized image data value is greater than the threshold value, and numerating the growth degree of grains on the surface of the numerical target zone by calculating a ratio of the number of the counted pixels with respect to the number of total pixels disposed within the numerical target zone. A display section or screen then displays the calculated ratio.

[0075] The computer section can also form mesh lines for dividing the screen into a plurality of sub areas over the displayed image, and allowing an operator to select a numerical target zone by selecting a designated sub area.

[0080] It is desirable that, before performing the standardization, the computer section performs a smoothing process for smoothing the image data of the respective pixels disposed within the numerical target zone using an average value of image data of adjacent pixels.

BRIEF DESCRIPTION OF THE DRAWINGS

[0085] The above objects and other advantages of the present invention will become more apparent by describing in detail preferred embodiments thereof with reference to the attached drawings in which:

[0090] Fig. 1 is an exploded schematic view showing an apparatus for numerically analyzing a growth degree of grains on a surface of a semiconductor wafer in accordance with an embodiment of the present invention;

[0095] Fig. 2 is a cross-sectional view of an OCS-type capacitor having HSGs grown thereon;

[0100] Fig. 3 is a flowchart showing a first numerical algorithm for numerating the growth degree of grains on the semiconductor wafer;

[0105] Fig. 4 is a flowchart showing a second numerical algorithm for numerating

the growth degree of grains on the semiconductor wafer;

[0110] Fig. 5 is a view showing mesh lines formed over an SEM image frame of one OCS-type capacitor cell;

[0115] Figs. 6A and 6B are views showing magnified SEM images of predetermined upper and lower portions in a numerical target zone shown in Fig. 5, respectively;

[0120] Figs. 7A and 7B are exemplary views of magnitude distributions when image data values of the SEM images shown in Figs. 6A and 6B are divided into five grades by changing the image data value from 0 to 250, respectively;

[0125] Figs. 8A and 8B are exemplary views of images obtained after standardizing the image data of the SEM images shown in Figs. 6A and 6B, respectively;

[0130] Fig. 9A is an exemplary view of an image before performing a smoothing process, and Fig. 9B is an exemplary view of an image after performing a smoothing process;

[0135] Figs. 10A to 10C are exemplary views of images showing a calculated value of the growth degree of the HSGs and a growth state of the HSGs, respectively;

[0140] Figs. 11A to 11C are exemplary views showing an SEM image and a calculated growth degree of the HSGs when the numerical algorithm is applied by setting a threshold value to 121; and

[0145] Figs. 12A and 12B are graphs showing a calculated result of the growth degree of the HSGs according to a measuring portion of the semiconductor wafer and a growth time of the HSGs, respectively.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0150] The present invention will now be described more fully with reference to the accompanying drawings, in which a preferred embodiment of the invention is shown.